

United States General Accounting Office

GAO

AD-A244 834



Report to the Chairman, Subcommittee
on Defense Industry and Technology,
Committee on Armed Services, U.S.
Senate

January 1992

DEFENSE INDUSTRIAL BASE

Industry's Investment in the Critical Technologies



92-01807



National Security and
International Affairs Division

B-242856

January 15, 1992

The Honorable Jeff Bingaman
Chairman, Subcommittee on Defense
Industry and Technology
Committee on Armed Services
United States Senate

Dear Mr. Chairman:

In response to your request, we obtained information on the extent of contractors' Independent Research and Development/Bid and Proposal (IR&D/B&P) efforts on the Department of Defense (DOD) designated critical technologies.¹ As you requested, we also obtained the contractors' views about how their IR&D/B&P programs would be affected by a 1990 legislative change designed to, among other things, encourage defense contractors to promote the critical technologies, develop dual-use technologies (those with both military and commercial applications), and address environmental research.

Background

For many years, DOD has sponsored research and development (1) directly by issuing a contract or grant and (2) indirectly by allowing contractors to include IR&D/B&P in overhead costs.

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IR&D is research and development that is not specified under any government contract or grant. B&P costs are incurred in preparing, submitting, and supporting bids and proposals on potential contracts, including technical background work. In fiscal year 1990, DOD reported that 121 defense contractors spent a total of \$7.3 billion on IR&D/B&P costs. The DOD report includes data on major defense contractors that had an annual auditable volume of costs incurred in excess of \$40 million—these contractors provide the large majority of IR&D/B&P.

** Contract proposals, * Research management*
In 1990, Public Law 101-510 required DOD to revise its IR&D/B&P regulations to encourage contractors to engage in research and development activities that (1) strengthen the defense industrial and technology base, (2) enhance the nation's industrial competitiveness, (3) promote the critical technologies, (4) support dual-use technologies, and (5) address



¹ Critical technologies are technologies DOD considers essential for maintaining the qualitative superiority of U.S. weapon systems. They are listed in DOD's Critical Technologies Plan, which is issued annually.

environmental research. In 1991, Public Law 102-190 revised the statutory requirements governing the reimbursement of IR&D/B&P, but retained these five objectives.

To assist in the overall management of DOD's research and development programs, Congress requires the Secretary of Defense to annually prepare a Critical Technologies Plan that identifies technologies needed to ensure the long-term superiority of U.S. weapon systems.

Results in Brief

DOD does not currently gather information on whether contractors' IR&D/B&P expenditures are addressing the technologies considered to be the most critical to ensuring the long-term qualitative superiority of U.S. weapon systems. We surveyed 121 contractors in this program; 92 contractors reported that in 1990 they spent a total of \$2.9 billion, or almost 50 percent, of their IR&D/B&P expenditures on the goals² listed in DOD's Critical Technologies Plan. They also told us that most of their firms' total IR&D/B&P work is on near-term developmental efforts aimed at designing, developing, or testing a new or improved product.

Sixty percent or more of the contractors we contacted expressed the opinion that Public Law 101-510 will have little or no effect on their investments in the critical or environmental technologies, and almost 45 percent believe that the law will have little or no effect on the work being done related to dual-use technologies.

Defense Contractors Invest Billions in DOD's Designated Critical Technologies

For fiscal year 1990, the 92 defense contractors that responded to our questionnaire indicated that they had spent a total of \$6.1 billion on IR&D/B&P and of this amount \$2.9 billion, or about 50 percent, had been used to address the technical goals in DOD's Plan. Most of the firms' total IR&D/B&P work is for near-term developmental efforts, as opposed to basic research³ or applied research,⁴ which are considered to reflect the longer term research efforts. It seems likely that the part of

² Each critical technology contains specific technical goals that are intended to be achieved within 5, 10, and 15 years.

³ Basic research is directed at increasing knowledge of science. Its aim is greater understanding of the subject under study rather than any practical application.

⁴ Applied research (1) normally follows basic research, but may not be severable from the related basic research; (2) attempts to determine and exploit the potential of scientific discoveries or improvements in technologies, materials, processes, methods, devices, or techniques; and (3) attempts to advance the state of the art. Applied research is not aimed at design, development, or test of specific items or services to be considered for sale.

the IR&D/B&P work that is on critical technologies is also for such relatively near-term efforts.

Table 1 shows the estimated division of the IR&D/B&P effort between the critical technologies for fiscal year 1990.

Table 1: Estimated Division of IR&D/B&P Expenditures Between Critical Technologies for Fiscal Year 1990

Dollars in millions

Technology	IR&D	B&D	IR&D/B&D	% of total
Air breathing propulsion	\$458.6	\$57.6	\$516.2	18.1
Semiconductor materials	272.7	67.2	339.9	11.9
Signal processing	160.7	112.0	272.7	9.5
Passive sensors	175.7	95.8	271.5	9.5
Simulation and modeling	165.7	77.5	243.2	8.5
Composite materials	151.9	47.0	198.9	7.0
Parallel computer architecture	113.6	36.4	150.0	5.2
Sensitive radars	95.2	53.6	148.8	5.2
Software producibility	89.3	51.5	140.8	4.9
Photonics	92.3	24.7	117.0	4.1
Computational fluid dynamics	50.4	53.7	104.1	3.6
Data fusion	58.4	44.0	102.4	3.6
Machine intelligence/ robotics	63.7	19.2	82.9	2.9
Weapon system environment	25.6	25.1	50.7	1.8
Hypervelocity projectiles	15.7	24.3	40.0	1.4
High energy density materials	23.7	15.5	39.2	1.4
Pulsed power	13.5	3.8	17.3	0.6
Superconductivity	10.7	1.9	12.6	0.4
Biotechnology	5.7	3.4	9.1	0.3
Total	\$2,043.1	\$814.2	\$2,857.3	100.0

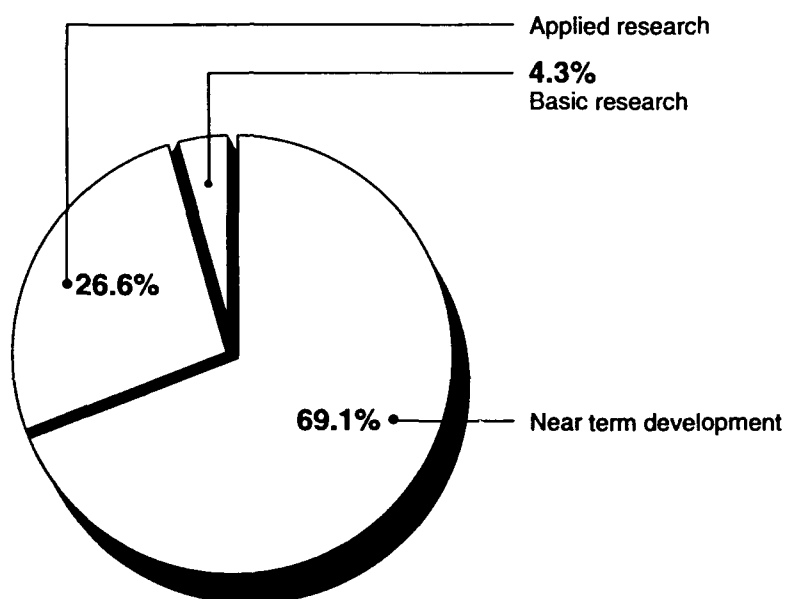
Note: Contractors reported \$168.6 million for signature control. However, the Critical Technologies Plan does not list goals for this technology because they are classified.

Table 1 shows that 30 percent of the estimated expenditures on critical technologies was spent on two critical technologies and less than 1 percent each on three other technologies. DOD does not tell contractors where to invest their IR&D/B&P efforts, but it does direct other research and development efforts that are acquired under government contracts or grants. The type of information contained in table 1 would assist DOD in allocating funds to achieve the technical goals.

Contractors Use Their IR&D Funds for Near-Term Efforts

Although the surveyed defense contractors spent approximately \$2.9 billion of their IR&D/B&P funds in the DOD-designated critical technologies, as figure 1 shows, the better part of their overall IR&D/B&P work, about 69 percent, was for near-term developmental efforts.

Figure 1: Approximate Allocation of All IR&D/B&P Expenditures by Type of Research for Fiscal Year 1990



According to DOD officials, the above distribution is understandable because the basic aim of these companies is to develop products in the near term. Basic research and applied research are longer term efforts aimed at increasing the knowledge of science and exploiting scientific discoveries. These projects tend to have higher risks and require more time to recoup investments. Contractors told us that they would rather expend funds on developmental projects expected to provide a return on their investment in relatively short time frames.

Defense Industry Views on the Impact of the 1990 Legislation

Table 2 summarizes the contractors' responses to questions about the potential impact on the 1990 legislative change on the IR&D/B&P program.

Table 2: Predicted Impact of Legislative Mandate to Encourage IR&D/B&P Work in Three Areas

Extent of work affected	Critical	Dual use	Environmental
Very great	2.3	3.8	2.7
Great	3.0	7.7	4.7
Moderate	11.9	21.4	7.2
Some	20.6	21.3	13.6
Little or no	60.6	44.6	67.5
Don't know	1.5	1.1	1.9
Total	100.0	100.0	100.0

Note: Figures represent the percent of respondents.

Less than 35 percent of defense contractors believe that the legislation would have even a moderate effect on the work being done related to dual-use technologies. Sixty percent or more believe that there will be little or no effect on investments in the critical or environmental technologies.

DOD Does Not Collect Data Linking IR&D/B&P to Critical Technologies

Currently, defense contractors report to DOD's Defense Technical Information Center such things as the content, estimated costs, and time frames for each IR&D project. They also categorize each project as basic research, applied research, or developmental. However, they do not report how much of the expenditures are spent on critical technologies. The data base contains no information on B&P projects.

Without a mechanism for effectively determining whether and to what extent IR&D/B&P program funds are being used to promote the development of critical and dual-use technologies or to address the environmental concerns, DOD is not in a position to ensure that the IR&D/B&P program is being carried out as intended.

DOD officials indicated that they had no plans to modify the data base, but acknowledged that the data base could be modified to determine whether and to what extent IR&D expenditures are being used to fund the long-term technical goals contained in the Critical Technologies Plan.

In addition, DOD officials indicated that the data base could be modified to determine how the recent legislative changes affect investment in dual-use and environmental technologies.

Recommendation

We recommend that the Secretary of Defense ensure that data, at least on IR&D programs, be routinely obtained to determine the extent to which contractors are executing projects that promote the critical technologies, develop dual-use technologies, and address environmental concerns.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD agreed with the findings, but disagreed with our recommendation. DOD stated that implementing the recommendation would place an additional and unnecessary burden on defense contractors.

This position is contrary to what our review showed. We found that contractors were familiar with the Critical Technologies Plan, and therefore were able to readily respond to our questionnaire. We believe that DOD could modify its existing IR&D data base to obtain the type of information that we gathered through our questionnaire. We believe that the information would be useful in identifying IR&D efforts that industry is conducting, thereby allowing DOD to respond to gaps in the defense industrial base. IR&D is an important component of the defense industrial base. DOD could use this information in deciding where to invest its other research and development funds. DOD needs to provide adequate assurance that it has sufficient data concerning the defense industrial base.

Scope and Methodology

We developed and tested a questionnaire during on-site interviews with selected defense contractors. We distributed these questionnaires to all firms listed in DOD's March 1990 report on IR&D/B&P costs.⁵ These contractors perform the overwhelming amount of IR&D/B&P.

We asked the contractors to report (1) their total IR&D/B&P expenditures for fiscal year 1990, (2) the percent of their total IR&D/B&P effort allocated to each of the critical technologies, (3) the percent of their work on critical technologies that addressed the short- and long-term goals for each technology, and (4) the division of their total IR&D/B&P work by type of research. The list of technologies in items two and three of the questionnaire was to be based on the March 1990 Critical Technologies Plan—the most recent Plan available at the start of our review.

⁵ Independent Research and Development and Bid and Proposal Costs Incurred by Major Defense Contractors in the Years 1988 and 1989, Defense Contract Audit Agency, March 1990.

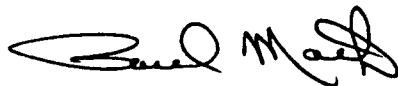
Respondents were initially asked to divide their effort between the critical technologies using only a one- to five-word description of the technology. The respondents then reported on the proportion of their total critical technology effort that had been specifically identified as a short-term or long-term goal in the March 1990 Critical Technologies Plan. In this report only the efforts that come under the specifically identified goals are counted as efforts on critical technologies. The goals for 1 of the 20 technologies, signature control, are classified. As a result, expenditures for signature control are not included in this report.

We also asked contractors to comment on the impact of the 1990 legislation on their IR&D/B&P programs. (See app. I for the exact wording of the questions and the aggregated results.) Of the 121 questionnaires sent, we received 92 responses. These 92 contractors represent over 80 percent of the dollar value of the entire IR&D/B&P program. We did not independently verify the data provided by these contractors.

We conducted our work between December 1990 and July 1991, in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Secretary of Defense; other interested congressional committees; and the Director, Office of Management and Budget. We will make copies available to others upon request. Please contact me at (202) 275-8400 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix II.

Sincerely yours,



Paul Math
Director, Research, Development,
Acquisition, and Procurement Issues

Aggregated Responses to Questionnaire Sent to Defense Contractors



U.S. GENERAL ACCOUNTING OFFICE

STUDY OF IR&D/B&P EFFORT AND DOD'S CRITICAL TECHNOLOGIES

INTRODUCTION

The U.S. General Accounting Office (GAO), an agency of the Congress, has been asked by the Congress to obtain industry reaction to new IR&D/B&P legislation and to determine how IR&D/B&P effort being performed by contractors relates to the 20 technologies which have been designated as "critical" technologies by the Department of Defense.

DCAA publishes a yearly report (IR&D/B&P Cost Incurred by Major Defense Contractors) which shows the amount of IR&D/B&P work. Our primary objective for this study is to provide an approximate estimate of how this IR&D/B&P effort is divided between different technologies. This questionnaire asks you to provide such an approximate indication for your firm or segment for your 1990 fiscal year.

The remainder of this questionnaire consists of three pages, one for IR&D, one for B&P and one for the new IR&D/B&P legislation. Each of the first two pages requests that you report the proportion of your IR&D/B&P work which addresses each of the DOD's 20 critical technologies. The questions also ask that you indicate how much of the work for each technology falls within specified subtechnologies which are defined in the enclosed "Subtechnologies list".

All the information provided on this form will be treated as confidential by GAO. Our report will only present data in an aggregated form so that no individual technology will be identified with any segment or firm.

Our experiences during the questionnaire pretest indicate that an IR&D or B&P manager will usually be able to complete these forms without extensive consulting with any other personnel. The forms request only an approximate estimate of the division of effort between the 20 technologies. This will not be regarded as an official cost estimate.

Please return the enclosed form within three weeks in the enclosed, self-addressed business reply envelope. If the envelope is misplaced, the return address is:

Attention: Michael Kennedy
U.S. General Accounting Office
Suite 760
841 Chestnut Street
Philadelphia, PA 19107

If you have any questions or if we can provide any assistance, please place a collect call to Mike Kennedy (215) 574-4000. We appreciate your effort in meeting this request.

RESPONDENT DESCRIPTION

- 1 What is the name of your segment and/or firm? (1-10)

(Segment/firm name) (11-14)

(SIC CODE) [Note: The segment or firm's SIC code appears on Cost Accounting Standard Board Disclosure form, Question 1.3.0.]

- 2 What are the name, address and telephone number for the person who should be contacted if we have further questions about this information?

(Name)

(Position)

(Street address)

(City, State and ZIP code)

(Telephone number)

- 3 The next two pages ask for data for your firm's 1990 fiscal year. On what date did that fiscal year begin? (15-20)

(Month) (Day) (Year)

**Appendix I
Aggregated Responses to Questionnaire Sent
to Defense Contractors**

I R & D REPORTING PAGE

4 How much did your firm or segment spend on IR&D during your 1990 Fiscal Year?(IF NO IR&D WORK, ENTER "0" AND SKIP TO B&P PAGE) (21-30)
\$ _____

5 Approximately what percentage of your reported IR&D work comes under each of the following classifications? (Percentages should total to 100%.) (31-42)
 _____ % Basic research
 _____ % Applied research
 _____ % Developmental
 _____ % System Studies
 100 % TOTAL

INSTRUCTIONS FOR TABLE (Right side of page)

6 [COLUMN II INSTRUCTIONS]
Divide your total IR&D effort between each of the 20 listed technologies and all other work. Make this division so that it approximates the costs of those accounts. Do **NOT** limit the allocation to only technology development efforts. Work should be assigned to any technology which the IR&D effort develops or in any way addresses. The remaining IR&D work which has not been included under one of the 20 listed technologies should be reported as "OTHER" at the bottom of Column II.

7 [COLUMN III INSTRUCTIONS]
Examine the enclosed "subtechnologies" list for each of the identified technologies. What percent of your work on each technology is included within one of the listed subtechnologies and what percent is not included in a subtechnology?

IR&D information				
I	II	III		
Technology	Percent in each technology	% in listed subtechnologies		
		NOT		
		Listed	listed	TOTAL
Semiconductor materials and micro-electronic circuits	_____ %	_____	_____	= 100% 01
Software producibility	_____ %	_____	_____	= 100% 02
Parallel computer architectures	_____ %	_____	_____	= 100% 03
Machine intelligence and robotics	_____ %	_____	_____	= 100% 04
Simulation and modeling	_____ %	_____	_____	= 100% 05
Photonics	_____ %	_____	_____	= 100% 06
Sensitive radars	_____ %	_____	_____	= 100% 07
Passive sensors	_____ %	_____	_____	= 100% 08
Signal processing	_____ %	_____	_____	= 100% 09
Signature control	_____ %	(No subtechnologies)		
Weapon system environment	_____ %	_____	_____	= 100% 11
Data fusion	_____ %	_____	_____	= 100% 12
Computational fluid dynamics	_____ %	_____	_____	= 100% 13
Air breathing propulsion	_____ %	_____	_____	= 100% 14
Pulsed power	_____ %	_____	_____	= 100% 15
Hypervelocity projectiles	_____ %	_____	_____	= 100% 16
High energy density materials	_____ %	_____	_____	= 100% 17
Composite materials	_____ %	_____	_____	= 100% 18
Superconductivity	_____ %	_____	_____	= 100% 19
Biotechnology materials and processes	_____ %	_____	_____	= 100% 20
OTHER (All reported IR&D effort not included above)(Also answer Question 8)	_____ %			
TOTAL	100 %			

ANSWER IF "OTHER" WORK IN COLUMN II (above):

8 Are you developing or addressing other technologies which you feel are of equal importance for DOD (for example: ceramics, advanced coatings, flexible integrated computer manufacturing)?(Circle answer) (43)

1. YES (List up to three)

2. NO

(44)

Appendix I
Aggregated Responses to Questionnaire Sent
to Defense Contractors

B & P REPORTING PAGE

9 How much did your firm or segment spend on B&P during your 1990 Fiscal Year? (IF NO B&P WORK, ENTER "0" AND SKIP TO NEXT PAGE) (\$1-\$60)

\$ _____

INSTRUCTIONS FOR TABLE (Right side of page)

10 [COLUMN II INSTRUCTIONS]
Divide your total B&P effort between each of the 20 listed technologies and all other work. Make this division so that it approximates the costs of those accounts. Do NOT limit the allocation to only technology development efforts. Work should be assigned to any technology which the B&P effort develops or in any way addresses. The remaining B&P work which has not been included under one of the 20 listed technologies should be reported as "OTHER" at the bottom of Column II.

11 [COLUMN III INSTRUCTIONS]
Examine the enclosed "subtechnologies" list for each of the identified technologies. What percent of your work on each technology is included within one of the listed subtechnologies and what percent is not included in a subtechnology?

B&P information			
I	II	III	
Technology	Percent in each technology	% in listed subtechnologies	
		NOT	
		Listed	listed = TOTAL
Semiconductor materials and micro-electronic circuits	_____ %	_____ + _____	= 100% 31
Software producibility	_____ %	_____ + _____	= 100% 32
Parallel computer architectures	_____ %	_____ + _____	= 100% 33
Machine intelligence and robotics	_____ %	_____ + _____	= 100% 34
Simulation and modeling	_____ %	_____ + _____	= 100% 35
Photonics	_____ %	_____ + _____	= 100% 36
Sensitive radars	_____ %	_____ + _____	= 100% 37
Passive sensors	_____ %	_____ + _____	= 100% 38
Signal processing	_____ %	_____ + _____	= 100% 39
Signature control	_____ %	(No subtechnologies)	
Weapon system environment	_____ %	_____ + _____	= 100% 41
Data fusion	_____ %	_____ + _____	= 100% 42
Computational fluid dynamics	_____ %	_____ + _____	= 100% 43
Air breathing propulsion	_____ %	_____ + _____	= 100% 44
Pulsed power	_____ %	_____ + _____	= 100% 45
Hypervelocity projectiles	_____ %	_____ + _____	= 100% 46
High energy density materials	_____ %	_____ + _____	= 100% 47
Composite materials	_____ %	_____ + _____	= 100% 48
Superconductivity	_____ %	_____ + _____	= 100% 49
Biotechnology materials and processes	_____ %	_____ + _____	= 100% 50
OTHER (All reported B&P effort not included above)(Also answer Question 12)	_____ %		
TOTAL	100 %		

ANSWER IF "OTHER" WORK IN COLUMN II (above):

12 Are you developing or addressing other technologies which you feel are of equal importance for DOD (for example: ceramics, advanced coatings, flexible integrated computer manufacturing)? (Circle answer) (61)

1. YES (List up to three)

2. NO

(62)

**Appendix I
Aggregated Responses to Questionnaire Sent
to Defense Contractors**

1991 DEFENSE AUTHORIZATION LEGISLATION

The 1991 Defense Authorization Act directs DOD to change regulations which affect the types of costs which are allowable for IR&D/B&P. Under the previous act, IR&D projects had to have Potential Military Relevance (PMR) to be allowable. Under the new 1991 act, projects must be of potential interest to DOD. The new act also directs DOD to encourage IR&D/B&P work in the three areas enumerated in the next question.

- 13 If DOD implemented the regulations substantially as written in the 1991 Act, to what extent, if at all, would your work be affected in each of the following three areas? (If you do not do work in a particular area, check "Little or no".) (Check the appropriate answer) (63-65)

Type of area	Extent your segment's work affected:					
	Very great (1)	Great (2)	Moderate (3)	Some (4)	Little or no (5)	Do not know (6)
a. Development of the 20 critical technologies						
b. Development of technologies useful for both the private commercial sector and the public sector						
c. Development of efficient and effective technologies for achieving such environmental benefits as improved environmental data gathering, environmental cleanup and restoration, pollution-reduction in manufacturing, environmental conservation, and environmentally safe management of facilities.						

THIS IS THE END OF THE QUESTIONNAIRE. THANK YOU FOR YOUR ASSISTANCE.

Major Contributors to This Report

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